A SIMPLE, PORTABLE, COMPUTER-CONTROLLED ODOUR GENERATOR

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ABSTRACT

In this paper, we report on the on-going development of a simple computer controlled odour generator. The unit comprises of eight “aroma dispensers” that can be loaded with liquid samples (in our case fragrances such as tea-tree oil). These aroma dispensers use a combination of the capillary effect and thermal heating to release aroma to the user. The instrument also includes a controlled fan and a gas sensor to monitor the release of the aroma. Interaction with the aroma generator is through a custom interface that releases aromas in line with either direct control or a pre-programmed sequence. We believe this unit can be used in combination with virtual environments to enhance such experiences.

Index Terms— Aroma generator, digital olfaction, olfactory display

1. INTRODUCTION

Smell is one of the major human senses and is used continuously in our normal lives. However, technological developments in aroma generation still lag far behind developments for our other sensors – especially sight and sound. Current, main stream smell generation is based on perfume sprays, candles, air fresheners (aerosol or mist) or even liquid bottles and smelling strips. The reason behind this is complex, but can be linked to a severe lack in simple smell generating technologies. If such products existed, it could be possible to integrate “digital smell” into more of our modern lives. Such integration could lead to its use in virtual reality environments, historic displays (the smell of rotting fish!) or even within the medical arena to reduce anxiety and aid in sleep.

The concept of digital aroma generation is not new and has been around for more than a century. In fact, smell was used in cinemas before sound. However, the concept of digital olfaction only took hold in the 21st century. Over the last 20 years there have been around a dozen attempts to create smell generators with a (very) small number making it to market. The best known of these are DigiSense iSmell, Micro-fab technologue Pinoko and the TriSenx Smell Dome, though none of these are currently available [1]. There are a small number of products in development/available such as the oNotes Cyrano (though not outside the US) and the Scentee (Japan only), with the Feal-real face mask (for virtual reality) and Nosulus Rift (Ubisoft – for a specific game) in development.

This paper reports on our current work to develop, simple, low-cost aroma generating technology that can easily be constructed to help in the use of aroma engineering in a range of applications. Once developed, we intend to deploy it for a wide range of VR and medical applications.

2. DISPENSING APPROACHES

At the centre of any digital aroma technology is what we describe as the “aroma dispenser”. There is some previous literature on aroma dispenser and researchers have focused mainly on five different approaches covering:

- Inkjet printing technologies [2]
- Piezoelectric/surface acoustic wave [3]
- Air cannon [4]
- Pumps and valves [5]
- Thermal/heating [6]

In our drive to create a simple system, the first two options were discarded due to difficulties in design and manufacture, with many researchers working with printer manufacturers to make their products. The third option is a single aroma system and the fourth option makes the units expensive. For this reason, our aroma dispenser was based on a thermal/heating approach. We believe this is the simplest and lowest cost option to construct an aroma generator, with the additional merits of being soundless as is composed without mechanically-moving parts. However, it has the disadvantage that some chemical compounds are destroyed by heat, limiting the variation of odour materials [6].

3. MATERIAL AND METHODS

3.1 Aroma Dispenser

The choice of thermal heating still presents many different design opportunities from vaping approaches to external heater pads. In our design we constructed our aroma generator based on a combination of capillary effect and thermal heating. Here a 5 ml glass vial was selected (manufacturer). The vial screw cap lid was fitted with a PTFE septum to which was drilled two holes. Through the holes, two glass capillary tubes were pushed through and nickel chrome heating wire looped between the two tubes to form a heating element. Figure 1 shows the aroma dispenser in use.

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Here 5V was applied to the heating element and the unit produced vapour in under 5 seconds.

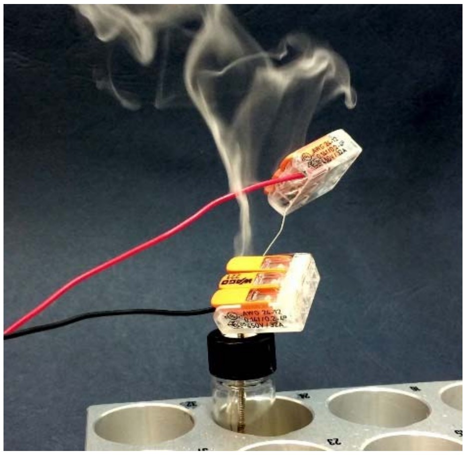


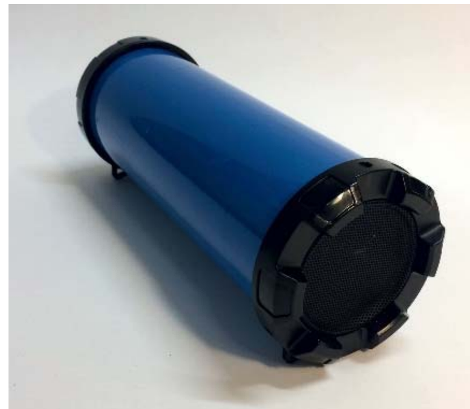
Figure 1: Aroma Dispenser

3.2 Aroma Generator

A unit was designed to drive/control up to eight of these aroma dispenser units. This number was chosen as in most applications, there is not a requirement for more channels and it ensured that the aromas lasted for a longer period of time.

A custom PCB was designed to hold these aroma dispensers. The heating element within it was controlled using a simple bang-bang controller and the temperature of the element was monitored through a change in resistance of the heating element. The unit also contained a speed controlled fan (part no. and manufacturer) and a metal-oxide gas sensor (AMS, AS-MLV-P2). The fan speed was controlled using a pulse width modulation (PWM) approach at 25kHz with the fan speed PWM output put through a low-pass filter and then measured. The gas sensor was driven/controlled using the general configuration supplied by the manufacture (PWM heater drive with a potential divider for the sensing element). The unit was driven by an Atmel AMDSAM18G M0 chip, which has multiple 12 bit ADCs (analogue to digital converters) to monitor the output from the gas sensor and the fan speed.

Figure 2: Aroma generator



The unit was also fitted with a Bluetooth module (TBC) to allow either wired USB communication/control or wireless. Figure 2 shows the inside of the aroma generator with a single aroma dispenser fitted. By being able to set the temperature and the flow rate over the Aroma generator we are able to have some control over the aroma concentration provided to the user. The unit itself is fitted into a 75 mm diameter tube and is 210 mm in length. Figure 3 shows the final aroma generator.

Figure 3: Completed aroma generator

3.3 Aroma Generator Software

To control the unit, a custom software interface was created. This was written in National Instruments LabVIEW (2016). The interface can communicate with the aroma generator either directly using USB or over Bluetooth. The current version of the software allows the user to select one or more aromas to be dispensed, the fan speed and the intensity of the aroma. Information on the state of the unit is then sent back for the user to monitor (if so desired). The software is also written so that an “event list” can be created. This is a series of timed events, where the user can select to have a specific aroma released at a specific time with a defined intensity and fan speed.

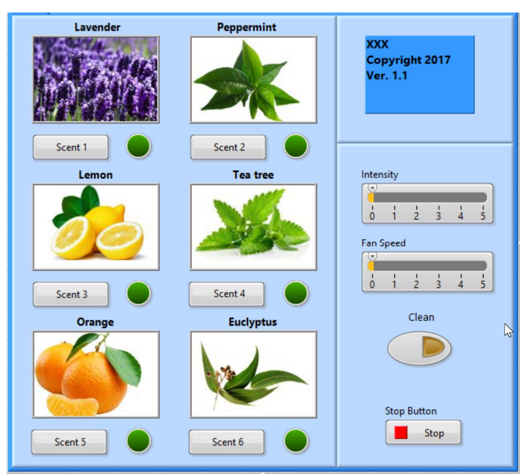


Figure 4: Aroma control software

This version of the software uses 6 aroma channels with the 7th channel given over to a clean. The clean is simply water vapour and is used to remove aromas from previous runs. Figure 4 shows the front interface of the software.

4. RESULTS

To test the functionality of the aroma generator, the emitted vapour concentration was measured at different distances from the generator, specifically 10cm, 20cm and 30cm away and at different emitting settings (which we describe as high, medium and low). The test was a total of 500 seconds, with a baseline period of 30 seconds, followed be a release of 120 seconds. The concentrations were measured using a commercial vapour instrument (Tiger, Ion Science UK) and for these. The results of this are shown in Figure 5 for a "high" setting.

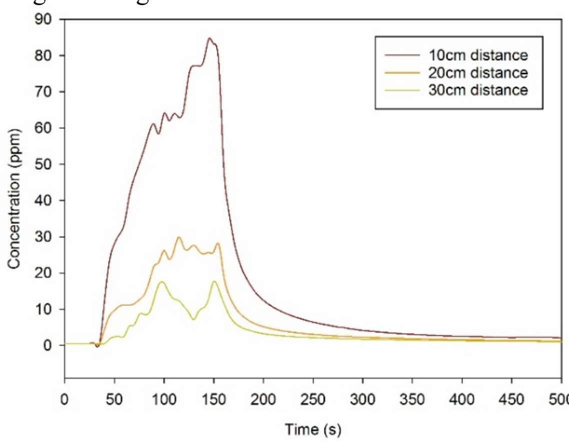


Figure 5: Concentration profile of aroma generator at different distances from the unit using peppermint oil.

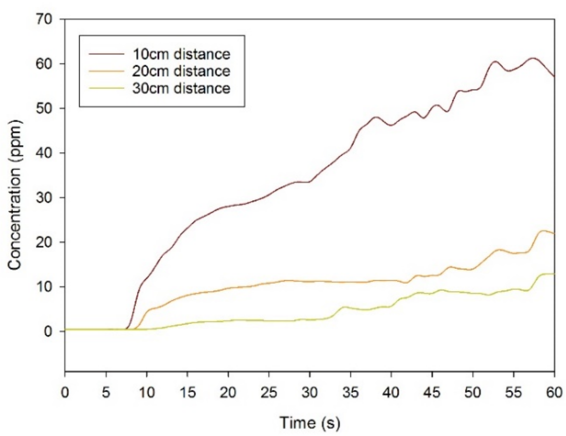


Figure 6: Dynamic response of aroma generator

We also investigated the length of time from an aroma being selected to it being emitted from the generator. These results of this are shown in Figure 6 again for low, medium and high concentration. As can be seen, the aroma is present in under 10 seconds (0 seconds refers to generator being initialised). Human perception of the smell aligned well with this value. Finally, we measured the output of the generator at medium and high at the three different distances. Figure 7 shows maximum concentration achieved for these settings.

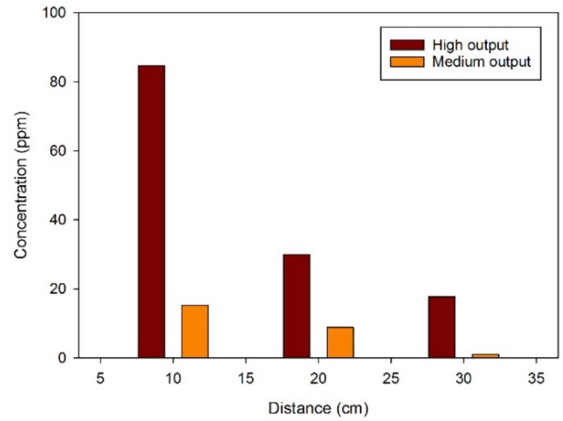


Figure 7: Effect of different output settings on odour concentration

5. CONCLUSIONS

In this paper, we show our current work in developing a simple, portable computer smell/aroma generator for use in a range of entertainment applications. The present unit holds 8 different liquid phase aromas (in our case essential oils) that can be released either directly by the user or controlled via a computer controlled sequence. The release mechanism is a thermal heating approach and is used in combination with a capillary tube within the aroma dispenser. In the future we will be connecting our system to a VR configuration to evaluate its effectiveness when undertaking real olfactory display tasks.

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